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ORIGINAL ARTICLE

Severely comminuted proximal femoral fractures: one implant may not solve the problem

Mohamed Ali[1]

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Abstract
Background Severely comminuted proximal femoral fractures present a complex problem with anatomical, biological, and functional dimensions. The objective of this study is to evaluate the concept of primary protected fixation using the reverse less invasive stabilization system (LISS) plate augmented by anterior plate±bone grafting.
Material and methods From August 2007 to August 2012, 19 patients, 13 males, and 6 females suffering from comminuted proximal femur fractures, types IV and V as per the Seinsheimer classification, were managed. Full active range of motion of the hip and knee joints and nonweight bearing (wt-b) ambulation were allowed from the second postoperative day.
Results Only 19 patients were available for complete follow-up for a mean period of 18±9.66 months. Full wt-b was achieved in a mean time 6.8±3.1 weeks. All the fractures achieved union without further intervention. Only one case had delayed union to 7 months. The mean time to radiological union was 3.8±1.56 months (range 3–7 months). None of the cases had nonunion, varus collapse, screw cutting through the femoral head, implant related problems, or limb shortening. Two cases got superficial infection. All patients except two regain their original job. Sports practice was regained in 15 patients (78.9 %) in a mean time of 7.6 months.
Conclusions Sometimes, one implant may not satisfy the surgeon, offer a stable fixation, or solve the patient's problem. This protected fixation represents a frequent option in revision surgery. But, in primary fixation, it has to be reserved to special types of fractures, with them high failure is suspected. It offers a protected stable fixation that can withstand the stresses.

Keywords Subtrochanteric fractures · Internal fixation · Nailing · Plating

✉ Mohamed Ali
profmoali@yahoo.com

[1] Department of Orthopedic Surgery and Trauma, Minia University Hospital, M. Badawy St, 61111 El-Minia, Egypt

Introduction

The extracapsular proximal femur fractures include intertrochanteric and subtrochanteric fractures. It may be difficult to delineate them, but the fracture is usually named according to the site of the major displacement [1]. These fractures account for 10–34 % of all hip fractures with two peaks. One peak in elder osteoporotic patients with low-energy trauma and the other in young adults with high-energy injuries and severely comminuted fracture [1–5]. Subtrochanteric femur fractures present a treatment challenge because of the peculiar anatomical and biomechanical features, the increased stresses, the lack of consensus for treatment, the difficulty in fixation, and the high risk of failure regardless of the fixation method [6]. Despite the great development of the treatment methods and implants, the treatment of choice remains controversial [7–9] and high rates of malunion and nonunion were reported [1, 2].

The aim of surgery is to achieve initial stability and early mobilization to regain the pre-injury level of activity and avoid complications [10]. Implant choice becomes more critical in unstable fractures to sustain the biomechanical demands of weight bearing and significant muscular forces for prolonged periods required for healing. This may explain the high rates of malunion and nonunion followed by fixation failure than other femoral fractures [1, 2, 10]. Many treatment alternatives exist; however, they can be grouped into two groups, the cephalomedullary nails and the lateral plate–screw systems [10–12]. Intramedullary devices are biologically superior; however, adequate reduction may be difficult, supplementary fixation materials may be required, and hip abductor strength is questionable [13–16]. Lateral plate–screw systems offer stable and mechanically stronger fixation but requires more extensive soft tissue dissection with its known complications [17, 18]. Until recently, the lateral trochanteric wall becomes considered to be important in stability that can assist healing and reduce malunion or nonunion [19]. Side plating of the proximal femoral provides a stress shield for the lateral trochanteric wall and prevents the lateral migration of proximal fragments [20]. Despite its early promising results with the proximal femoral locking plate, high failure rates reaching 70 % were documented [21]. Our successful revision of failed cases by the protected (augmented) fixation motivated us to use this technique primarily with unstable or severely comminuted proximal femur fractures where one implant may not be enough to regain structural competence to withstand the high stresses and avoid the high rates of failure. We used a reverse less invasive stabilization system (LISS) plate augmented biologically by bone grafting or graft substitutes and mechanically by anterior plating with two anteroposterior screws in the superior and inferior fracture fragments.

Materials and methods

The inclusion criteria for this study included four-part or more comminuted subtrochanteric femur fractures corresponding to types B3 and C3 in AO Foundation and Orthopaedic Trauma Association (AO/OTA) classification or types IV and V in the Seinsheimer classification. The exclusion criteria include simple fractures, open fractures, pathological fractures, and fractures in polytrauma patients. From August 2007 to August 2012, we treated 368 patients with extra-capsular proximal femur fractures. From them, 52 patients met the inclusion criteria. After approval of the Local Ethical Committee, 25 patients accepted and were consented to participate in the study, but only 19 of them completed the follow-up period. These 19 patients only will be reported throughout the manuscript. Plain radiographs were taken on admission, including anterior–posterior (AP) and lateral calibrated plain radiographs of the entire femur. The time elapsed from the patient's presentation until the surgery was no longer than 48 h. Thromboembolic and antibiotic prophylaxis were used in all cases.

Operative technique

All surgeries were performed on a traction table under image intensifier. As a principle, the main lateral plate was long reverse LISS distal femur plate. A small incision just enough to reduce the main fracture fragments was done. Its length and level were determined by the level and displacement of the main fragments. The big fragments were reduced using a pointed reduction clamp or K-wires as joysticks to avoid stripping of their soft tissue attachments. Then, the reduction is maintained with interfragmentary screws (Fig. 1c). We used a long reverse (LISS or anatomical distal femur locked plate) as the main implant inserted laterally. The augmentation plate was narrow or reconstruction locked plate. The lateral plate was introduced through the wound and pushed, through a submuscular tunnel, distally and then proximally to the required level. Its level was tested by C-arm before fixing one screw above and below the fracture zone. Small or crushed butterfly fragments were left untouched. The anterior augmentation plate was inserted through the same wound without additional dissection or soft tissue stripping in the same way. Its length varied according to the size of the comminuted fracture zone need to be bypassed to allow placement of two screws proximal and distal to it. After fixation of one screw in each side of the fracture zone, reevaluation of the alignment was done clinically and radiologically before the rest of the screws were applied (Fig. 1d, e). The evaluated alignments include reduction of the main fracture fragments, neck–shaft angle, anteversion angle, length, and absence of rotation. The screws of the two plates were applied through the opened wound or percutaneous without wound extension. Any structural defect was filled by autogenous iliac bone graft and/or graft substitutes. We prefer to use long upper screws in the neck to avoid stress riser effect, but, in the presented case, short screws were used exceptionally. This was due to a supply problem and fortunately without complications. All efforts were done to minimize soft tissue stripping and avoid devascularization of the fracture fragments. All patients had closed suction drainage of the wound. Figure 1 presents a case of Seinsheimer type 4 fracture.

Postoperative management

The wounds were inspected on txhe fifth postoperative day, and the sutures were removed after 14 days. The antibiotic prophylaxis was continued postoperatively for 3 days according to our hospital protocols. Movements in bed, sitting in a wheelchair, full active range of motion of the hip and knee joints, and non-weight bearing ambulation were allowed for all patients from the second postoperative day.

Radiological follow-up AP and lateral radiographs were obtained to inspect the implant position, fracture alignment, and progress of union immediately after surgery and at 6, 12, and 24 weeks. After radiographic documentation of adequate fracture healing, the patients were reviewed every 6 months until end of the follow-up.

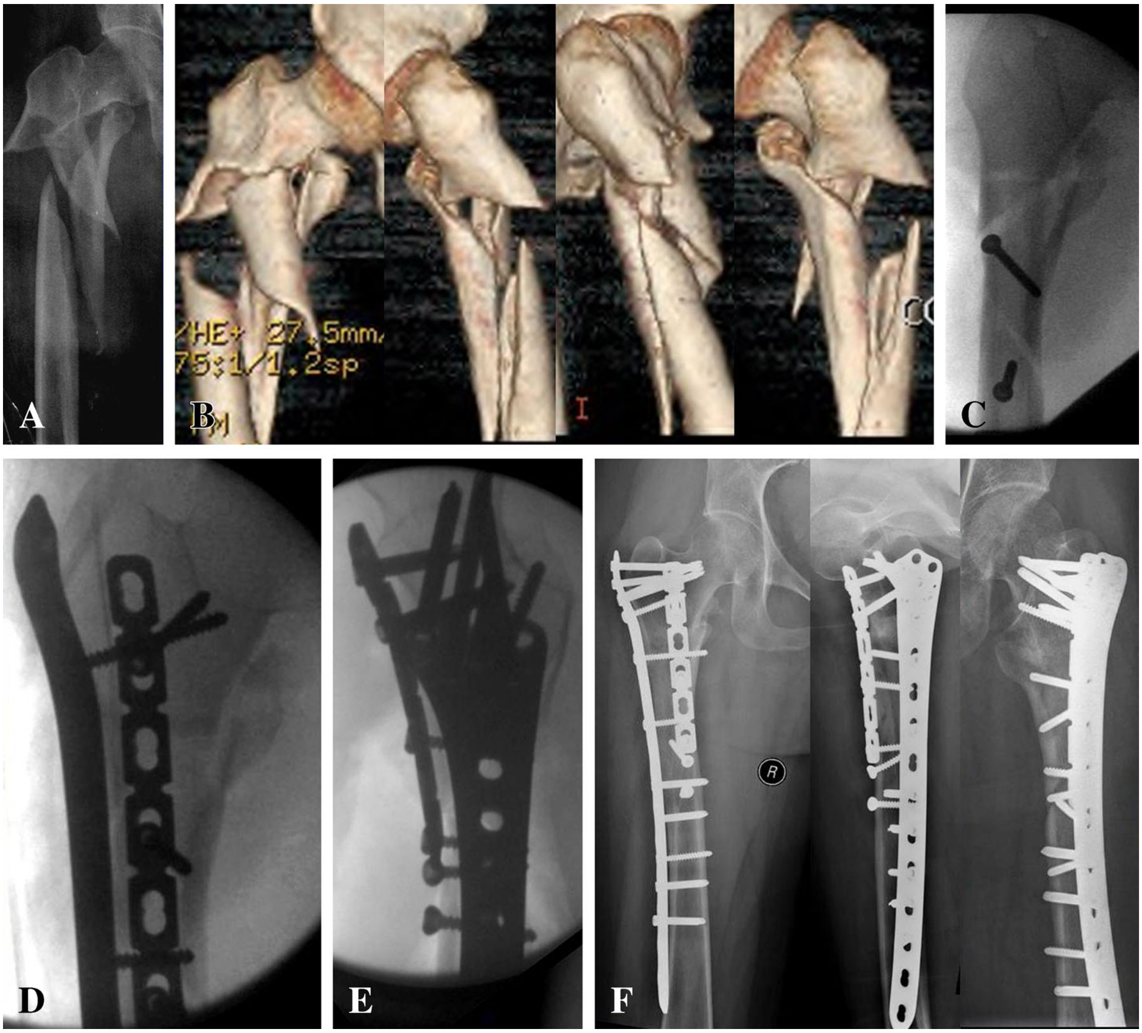

Fig. 1 A 28-year-old female patient with Seinsheimer type IV fracture. **a** Preoperative plain X-ray. **b** Preoperative 3 dimensional CT views. **c** Intraoperative C-arm photo after reduction and interfragmentary screw fixation. **d** Intraoperative C-arm photo after fixation of two screws in each plate. **e** Intraoperative C-arm photo after full screw application. **f** Plain X-ray follow-up after 3 months

Weight bearing A decision regarding full weight bearing was made on an individual basis according to age of the patient, preoperative mobility, extent of coexisting injuries, fracture location and amount of comminution, and progress of healing. Toe touch weight bearing (wt-b) was permitted when callus starts to appear in the X-ray. This was gradually progressed to full wt-b according to the progress of fracture healing. Physical therapy was routinely used in all patients including active range of motion, resistive muscle strengthening, and gait training.

Follow-up

Clinical evaluation The evaluated variables included the operative time, blood loss, radiation exposure time, hospital stay, wound problems, time to full wt-b, time to radiological union, union problems, secondary operative procedures, hip pain, abductor weakness, presence of a limp, functional evaluation as per Harris hip score, and return to job and the pre-injury level of activity or sports. The patients were given an appointment 1 month postoperative to determine the start of wt-b and then every 3 months till fracture union and then every 6 months till end of the follow-up.

Statistical analysis This was performed using SPSS 19.0 for Windows (SPSS Inc., Chicago, IL). The unpaired independent *t* test was used to compare outcome measures with parametric means. The chi-squared test and Fisher's exact test were used to compare nonparametric means. The level of significance was set at *P* less than 0.05.

Results

Only 19 patients were available for complete follow-up. Thirteen patients (68.4 %) were males, and six patients (31.6 %)

were females. Their mean age was 43.4±18.37 years (range 22–57 years). Ten patients (52.6 %) were smokers, four of them stopped smoking postoperative, while six patients did not. A total of eight fractures occurred on the right side (43.1 %), and 11 (57.9 %) occurred on the left side. Fourteen patients (73.7 %) had Seinsheimer type IV fractures, while five patients (26.3 %) were classified as type V. According to the AO classification, nine fractures (47.4 %) were classified as type B3, while ten fractures (52.6 %) were classified as type C3. Thirteen fractures were caused by a motor vehicle accident (MVA), and six were caused by a fall from a height (Table 1).

The mean surgery time from cut to stitch was 96±20.7 min (range 80–135). The mean blood loss was 450±187 ml (range 300–700). Anterior augmentation plate was used in all cases. Iliac bone grafting was used in six patients (31.6 %) and graft substitutes in six patients (31.6 %), and both in two patients (10.5 %) and in five patients (26.3 %), no grafting was required. The mean image intensifier time was 1.1 min (range 0.7–2 min). Good medial buttress with no gaps was achieved in all cases.

The patients were followed for a mean period of 18.4±9.66 months (range 12–30 months). The mean hospital stay time was 4.6±2.15 days (3–7 days). Full wt-b was achieved in a mean time 6.8±3.1 weeks (range 5–10 weeks). All the fractures achieved union without further intervention. Only one case had delayed union to 7 months. The mean time to radiological union was 3.8±1.56 months (range 3–7 months). None of the cases had nonunion, varus collapse, screw cutting through the femoral head, implant related problems, or limb shortening. There were two cases of superficial wound infection which were cured by wound care and intravenous antibiotic therapy. The evaluated alignments of the main fracture fragments and the neck–shaft angle did not change between the postoperative and final X-rays. The mean number of physiotherapy treatments was 16.4±4.72 (range 10–24). Full ROM of the hip and knee was achieved in all cases. No limp or abductor lurch was encountered in any patient. Early unsupervised mobilization was documented in five cases but, fortunately, without effect on bony alignment, implants, or stability. All the patients except one regained their initially walking ability without pain or instability before 6 months. The patient with delayed union required 8 months to reach that level of walking ability. All patients except two could keep their original job. The patient with delayed union lost his job, and another one who had 58 years old changed his career. Return to sport activities was regained in 15 patients (78.9 %) in a mean time of 7.6 months (range 5–10 months). Four patients failed to regain their sports activity because of fear from refracture in two patients and for unknown cause, in another two. The mean Harris hip score was 90.5±7.6 (range 70–100). The overall results are presented in Table 2.

Table 1 Patients characteristics

Variable		Mean	Percent (%)
No. of patients		19	
Age (years)		43.4±18.37	
Sex	Male	13	68.4
	Female	6	31.6
Smoking	Total number	10	52.6
	stopped	4	
	Did not stop	6	
Fracture side	Rt	8	42.1
	Lt	11	57.9
Fracture type	Seinsheimer type IV	14	73.7
	Seinsheimer type V	5	26.3
	AO type B3	9	47.4
	AO type C3	10	52.6
Mechanism of injury	MVA	15	79
	Fall	4	21

Discussion

This study has several inherent limitations. It is a case series of a small number of patients, and the data analyzed here pertain to a specific type of injury. Also, the young population of the study may represent a bias in the results, but this may be related to higher frequency of high-energy trauma in our

Table 2 The overall results

Variable		Outcome
Follow-up period (month)		18.4±9.66 (12–30)
Mean operative time (min)		96±20.7 (80–135)
Mean blood loss (ml)		450±187 (300–700)
Mean image intensifier time (min)		1.1 (0.7–2)
Mean hospital stay time (days)		4.6±2.15 (3–7)
Grafting	Iliac bone graft	6 (31.6 %)
	Graft substitutes	6 (31.6 %)
	Both	2 (10.5 %)
	No	5 (26.3 %)
Mean time to full wt-b (week)		6.8±3.1 (5–10)
Mean time to radiological union (month)		3.8±1.56 (3–7)
Mean number of physiotherapy treatments		16.4±4.72 (10–24)
Infection	Superficial	2
	Deep	0
Nonunion		0
Painless walking ability before 6 months		18
Mean Harris hip score		90.5±7.6 (70–100)
Secondary surgeries		0
Return to job		17/19 (89.47 %)
Return to sports		15/19 (78.95)

Table 3 Comparison of the results of the current study and some previous studies

Study	No. of pts	Subtrochanteric fracture types	The implants used	Study type	Mean age (year)	Results
Jiang (2007)	49	All types	Long gamma nail and PFN	Retro-spective	53	OR and cerclage wiring/cable bandage in 17 cases Pain during walking in nine cases around the greater trochanter because of protruded nail, one case of delayed union.
Saarenpää (2007)	58	All types	Gamma nails in 43 patients	Pro-spective	Nails: 76.8	Nail group: two OR, four intraoperative shaft fractures, five supplementary fixation, one deep infection and one superficial, 20 % could walk without any aids at 4 months
			DHS in 15 patients (4 supplementary fixation)		DHS 74.1	DHS group: two device breakages, one fracture displacement, 8 % could walk without any aids at 4 months.
Rohilla (2008)	43	Comminuted: -AO (10 type 32B and 33 type 32C) -Seinsheimer (6 type III, 15 type IV, and 22 type V	Indirect reduction and mini-incision DCS fixation	Pro-spective	44	Mean follow-up 25 months (18–30), mean time to fwb 11 weeks (8–19), mean time to union 16 weeks (13–22), two malunions, seven limb length discrepancies (mean 1.5 cm), two coxa vara and persistent limp, one superficial infection, two restrictions of knee flexion beyond 90°, mean Harris hip score was 88 (range, 80–99), mean Merle d'Aubigne score was 17 (range, 14–18).
Neogi (2009)	40	Comminuted fractures	Biological plating using a DCS	Retro-spective	36	Mean time to union 15.6 weeks, five limb length discrepancies (mean 1 cm), four patients with rotational deformity. According to Sanders' criteria: excellent in 45 %, good in 50 %, and fair in 5 %
Ozkaya (2009)	27	Complex proximal femoral fractures	Reverse LISS	Retro-spective	71	Mean follow-up 24 months (range 15–32). Nonunion was observed in one patient, and mean Harris hip score was 73 points (range 58–85)
Liu (2010)	12	Seinsheimer type V fractures	DHS and shape memory alloy bow-teeth screw	Retro-spective	53	Mean follow-up 28 months (20–38), mean time to union 3.3 months (3–4.5), Merle d'Aubigne scores were 16.75±1.14, four cases excellent, and eight cases good.
Ma (2010)	20	Unstable proximal femoral fractures	Reverse LISS	Pro-spective	58	Mean follow-up 24 months (12–32), mean time to union 7 months (3–15), Parker and Palmer mobility scores: nine points for 17 patients and six points for 3 patients, shortening by 1.5 and 2 cm in two patients, mild pain in three patients and moderate in two.
Hu (2012)	45	Seinsheimer classification types III–V	Proximal lateral femur locking plates	Retro-spective	76	Mean follow-up 16 months (6–28), union in 43 cases, one deep infection and three superficial, two implant failures and 2ry surgery, five patients lost position, two femoral neck screw breakage, mean Harris hip score 86.5±9.8 (73–95), mean Parker and Palmer mobility score was 3–9 (7.4±2.1).
Saini (2013)	32	Unstable comminuted Seinsheimer types 3–5	Proximal femur-locking compression plate (PF-LCP).	Pro-spective	44.7	Mean time to union 15.62 weeks, two delayed unions, two infections, two shortenings of 1 cm, and one malunion with external rotation.
Song (2014)	11	Seinsheimer type V fractures	Reverse LISS combined with steel wire	Pro-spective	51	Mean follow-up 16 months (12–28), mean time to union 3.8 months (3–4.3), according to Merle d'Aubigne scores, excellent result in seven patients and four good.
Gunadham (2014)	26	AO types 32A–C	Proximal femur locking compression plate	Pro-spective	42.4	Cerclage wires were used in 12 patients (46.2 %), mean follow-up 11±6 months (6–25), two broken plates, two varus collapses, one

Table 3 (continued)

Study	No. of pts	Subtrochanteric fracture types	The implants used	Study type	Mean age (year)	Results
						broken screw, one nonunion, four secondary surgeries (three revisions with PFLCP and one with 135° angled blade plate).
Current study	19	AO 32-B3 and C3 fractures Seinsheimer type IV, V fractures	Reverse LISS, anterior augmentation plate, and bone graft and/or substitutes	Pro-spective	43.4	Mean follow-up 18±9.66 months (12–30), mean time to FWB 6.8±3.1 weeks (5–10), one delayed union, mean time to union 3.8±1.56 months (3–7), two superficial infections, one pain with walking, two job losses, four did not return to sports, mean Harris hip score was 90.5±7.6 (70–100).

locality and our failure to convince elder people to participate in the study. Despite the presence of many classifications, the subtrochanteric femoral fractures remain difficult to be classified and the actual borderline between trochanteric, subtrochanteric, and shaft fractures is debatable [5]. Because of the little uniformity between the classifications, we and other authors [5, 22, 23] used more than one classification system. Although the reliability of the Seinsheimer classification for subtrochanteric fractures has been questioned [24], Loizou et al [25] reviewed the literature, identified 15 different classification systems, and pointed out that the Seinsheimer classification was the most frequently used one followed by the AO/OTA classification. In this study, we have opted to use these two classifications. Only types IV and V in the Seinsheimer classification and types 32-B3 and 32-C3 in the AO/OTA were included in this study. These types were considered to be the most difficult types, with them high failure rates were suspected [10]. The subtrochanteric region of the femur is the most highly stressed region in the body because of the peculiar anatomical and biomechanical features. Being primarily consisted of cortical bone, it tends to fracture with comminution and heals slowly. The proximal fragment is short with wide medullary canal which makes nailing difficult, with the need for open reduction and supplementary materials for fixation in some cases. The attachment of powerful muscles deforms the major fracture fragments causing a difficulty in closed reduction and threatens the fixation. The eccentric loading pattern generated by the bending force of wt-b unequally loads the medial cortex in compression and the lateral cortex in tension with concentration of the compressive forces in the 1–3 in. below lesser trochanter [26]. This dissimilar loading pattern and the deforming muscle forces are of great importance in selecting the fixation device and protecting it from failure. So, restoration of the continuity of the medial cortex of the proximal femur has been considered as the key of success [27]. The lateral trochanteric wall is also important for stabilization and fixation, as its defect may lead to failure due to the decreased contact and ineffective healing of the bone ends [19, 28, 29].

The fixed-angle locking-screw plate system can be used for many of proximal femoral fractures, including subtrochanteric fractures extending to the basilar femoral neck and the shaft [30–33]. We agree with various authors who have used reverse LISS–distal femur locking plate with satisfactory results for unstable fractures of the proximal femur [33–35]. The reverse LISS plate as the main implant for fracture fixation acts as a fixed-angle internal fixator device and achieves greater stability compared with DHS, DCS, and angle blade plate while avoiding excessive bone removal. As the screws lock with the plate, the system is just like a fixator frame, which can hold all the major fragments without lateral stress on the greater trochanter fragment [36]. It has been reported that in unstable proximal femoral fracture with no lateral wall, no lag screw should be applied [37] (no lateral wall–no lag screw), as this leads to medialization of femoral shaft and lateralization of proximal femoral fragment. This results in deformity, nonunion, and screw cutout. The reverse LISS plate will buttress and substitutes for an incompetent lateral cortex and prevents excessive fracture collapse. Our results showed no varus collapse or hardware failure (Table 2). Mini-invasive surgery with avoidance of extensive periosteal dissection helps to maintain the blood supply of the main fracture fragments and faster fracture healing.

Effective preoperative planning is essential to determine the best approach for reduction and proper implants to fix these complex fractures that can withstand the stresses and avoid failure. This planning has to clarify which single implant can do this, or there is a need to prepare supplementary material. Also, another evaluation intraoperatively is required before and after fixation of the main implant to determine the need for supplementary fixation. With severe fracture comminution disrupting the main cortical support, a protected fixation with three-dimensional look (mechanical, biological, and functional) is required. Mechanically, reestablishment of medial cortical continuity by fracture reduction and/or grafting and lateral cortical buttress is crucial. The use of long lateral plate with spacing between the screws will buttress the lateral cortex and distribute the stresses over a long segment with low resultant stress/unit. This together with valgus reduction and reconstruction of the medial cortex will decrease the bending stress and prevent its accumulation at the common site of failure. The anterior augmentation plate will buttress the anteriorly displaced fragments and protect the medial cortex by counteracting the deforming bending stress of wt-b through the screws applied from anterior to posterior. Beside their biological role, bone graft and substitutes will also decrease the stresses by filling the defects preventing loss of the initial reduction into varus. Both of the augmentation materials will increase the stability of the fixation and restore the structural competence of fractured zone even with protected wt-b. We did not find any influence of the type of grafting on our results. The biological look includes the following:

1. Mini invasive approaches including a small opening at the main fracture fragments requiring reduction and inserting both plates and some screws, while the peripheral screws can be inserted percutaneous to avoid more extension of the soft tissue dissection.
2. Avoiding extensive soft tissue and periosteal stripping and reduction of the main fracture fragments while preserving their soft tissue attachments.
3. The role of bone graft and substitutes in osteo-genesis, induction, and conduction.

The functional look included early full range of motion, ambulation, and partial and full wt-b based on protected fixation.

This method of fixation has the advantage of being suitable for use in severely comminuted fractures; ipsilateral hip and shaft fractures; and subtrochanteric fractures with extension into the base of the neck, peritrochanteric region, or the shaft. It offers excellent stability and rotational control in complex fractures and can offer valuable salvage options for failed fixation of other devices used in the proximal femur. It allows rapid mobilization and early protected wt-b. Table 3 compares the results of the current study and some previous studies.

Although the early reports of fixed-angle devices showed high nonunion and infection rates (20 %) [38], but later, these complications could be reduced to 0–7 % because of improved operative techniques, indirect reduction, preservation of the vitality of fracture zone and newer implants [29, 30]. In this study, application of the anterior plate required no more dissection or extension of the approach as the plate can be applied through the wound while the screws can be applied through the wound or percutaneous.

In unstable subtrochanteric fractures, such as Seinsheimer IV–V with fragments that cannot be reduced by close reduction in a traction table, proximal lateral femur should be exposed open to reduce the fracture [37]. Medullary nails do not offer the same advantage of the minimally invasive plating procedures. Although the use of trochanteric entry cephalomedullary nails expanded the indications for nailing with ease of insertion and improved biomechanics and union rates, but re-operation was required in 8–12 % of patients to gain union [3, 39]. When using cephalomedullary hip nails to fix comminuted subtrochanteric fractures with a ruptured lateral wall or with a lateral fragment, the reaming of proximal femur would distract the fragments and cause peritrochanteric instability. The use of binding wire affects the blood supply at the fracture site, causing delayed union or nonunion [40]. A cerclage wires or cables and open reduction were occasionally required to reduce displaced fragments to align around the nail. In their study, to compare gamma nail and DHS for treating subtrochanteric fractures, Saarenpää et al. [5] reported the need for supplementary fixation in five cases (12 %) in the Gamma nail group and, in four cases (27 %), in the DHS group. Gunadham et al. [41] reported the use of cerclage wires in 12 patients (46.2 %) with LCP for treatment of subtrochanteric fractures. Others [42] reported that open reduction and fixation with cerclage wiring or cable bandage through a small incision was needed in the other 17/49 cases (34.69 %). They suggested that open reduction and cable bandage through a small incision may be performed before long gamma nail or long PFN insertion in the cases with long spiral fracture lines and unsatisfactory reduction under traction. So, this one implant was not enough to effect reduction and stable fixation. Another major concern was related to the insertion site morbidity, chronic pain, and the need for removal of a large amount of bone from the proximal femur which may affect the abductor strength and gait, if removal is required or need for future operations.

Some recent studies reported good results with supplemented fixation of Seinsheimer type V subtrochanteric fractures. Liu et al [43] treated 12 patients with dynamic hip screw and shape memory alloy bow-teeth screw fixation and considered it as a superior option that can get satisfactory reduction with reliable fixation and will be one of a better choice for fixation. Song et al [35] treated 11 patients with reverse LISS plate combined with steel wire and reported no complications. Although the results obtained in our study appear to be excellent especially in relation to union of all fractures primarily and absence of infection and implant failure, we did not consider this method to be the standard of care. But, it represents only an option available in mind of the surgeon for use when required as what is occurring with bone grafting. If one implant did not satisfy the surgeon, he can use this technique. It also represents a good treatment option for uncontrollable patient in whom nailing cannot be used or was not suspected to be efficient.

Conclusions

Sometimes, one implant may not satisfy the surgeon, offer a stable fixation, or solve the patient's problem. This protected fixation represents a frequent option in revision surgery. But, in primary fixation, it has to be reserved to special types of fractures, with them high failure is suspected. It offers a protected stable fixation that can withstand the stresses.

Conflict of interest The author declare that he had no conflict of interest

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